

JOINT TRANSPORTATION RESEARCH PROGRAM

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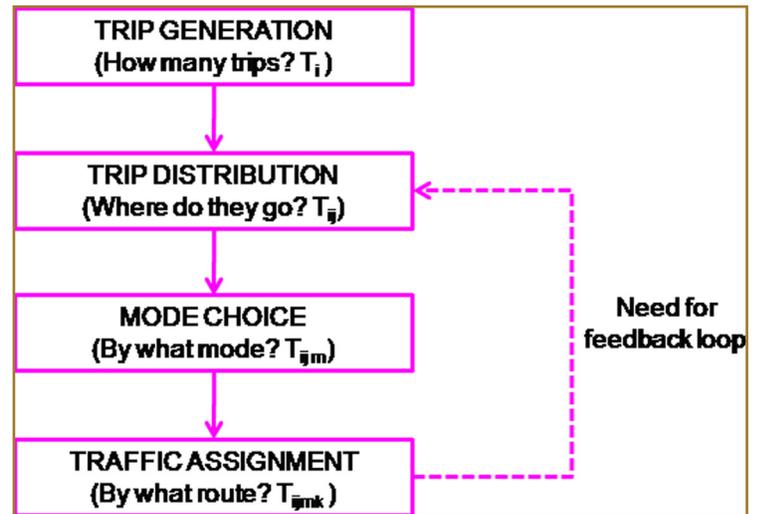
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Post-Processing Techniques to Enhance Reliability of Assignment Algorithm Based Performance Measures

Introduction

Travel demand modeling plays a key role in the transportation system planning and evaluation process. The four-step sequential travel demand model is the most widely used technique in practice. Traffic assignment is the key step in the conventional four-step planning process. It determines the estimated traffic flow pattern in the region of interest, and hence, identifies the volumes and levels of service on the various highways/streets. The estimated performance measures are then used for strategic decision-making. The traffic assignment problem is solved by utilizing the principle of user equilibrium (UE). However, there are some key issues related to stability, consistency, and convergence of the UE assignment that trouble practitioners and planners. These problems raise questions of reliability of the performance measures that represent the assignment algorithm solution outcome.

This study addresses the three practical issues: stability, consistency, and convergence related to the traffic assignment algorithm. The problem of consistency arises due to noise in the solution at lower convergence. The study develops an enhanced transportation planning framework by augmenting the sequential four-step planning process with the post-processing techniques. The post-processing techniques are incorporated through a feedback mechanism and aim to improve the stability and convergence properties of the solution, thereby improving the reliability of the planning process. There are three building blocks of the proposed post-processing module, namely slope-based multi-path algorithm or SMPA, perturbation assignment and O-D prioritization technique. SMPA is the most important part of the module and can be used as both post-processing algorithm or as an independent static traffic assignment algorithm. In addition to SMPA, the post-processing module consists of perturbation assignment and O-D prioritization schemes. Perturbation assignment provides warm start and O-D prioritization improves the rate of convergence by deciding the sequence in which the O-D pairs are brought into flow update process.



Conventional four-step travel demand modeling process.

Findings

The study findings can be separated into methodological contributions and insights from the computational experiments and data analysis. From the methodological point of view, the study formulates a static user equilibrium traffic assignment problem by decomposing the objective function of Beckmann's transformation into three parts which more rationally represents the flow update process. The study also derives the mathematical formulation of a new solution algorithm which is labeled as the slope-based multi-path algorithm or SMPA. It has better convergence characteristics compared to other potential algorithms in practice. A hybrid approach was developed by combining the merits of simultaneous and sequential approaches to foster fast implementation of UE assignment algorithms for large-size networks and was executed in SMPA. In this approach, the shortest paths are generated and sets of paths are updated for all the O-D pairs simultaneously. Then, paths for each O-D

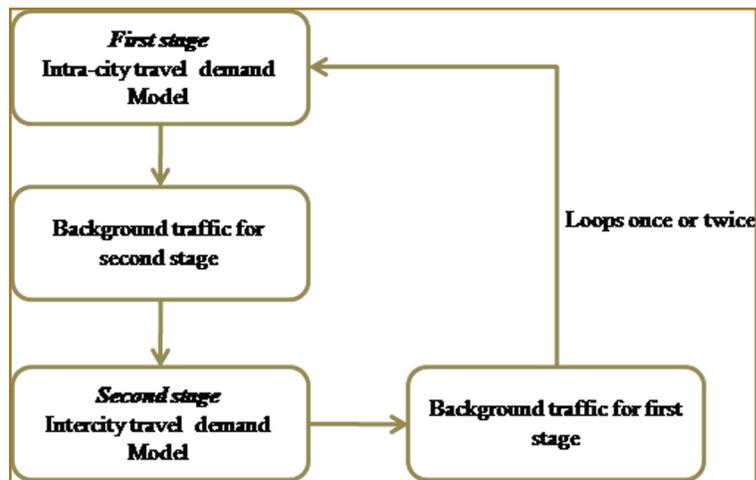
pair are equilibrated and flows are updated based on the sequential approach. For the assignment algorithms using sequential equilibration techniques, the order in which the O-D pairs are brought into the flow update process can have significant impact on the rate of convergence and the solution stability. In this study an implementation methodology for the O-D prioritization technique was developed and six criteria for O-D prioritization were conceived and tested for a real-sized network. In addition to SMPA and the O-D prioritization technique, the technique of perturbation assignment was studied for exploiting the potential of utilizing information from previous runs of the assignment algorithm for slightly different demand or link properties. A detailed implementation procedure for perturbation assignment was also developed to facilitate seamless implementation.

Computational experiments were performed to test the effectiveness of the post-processing techniques. Results of the computational experiments reveal that the SMPA has a superior rate of convergence compared to state-of-practice algorithms. Results of computational experiments further reveal that a warm start using perturbation assignment and O-D prioritization has significant benefits over the base case of cold start and non-prioritized implementation of SMPA. These three techniques will improve the convergence characteristics of the assignment process and provide a more stable solution having lesser noise and, thereby, increasing the reliability of the planning process. The efficient use of the previous runs of the assignment process using perturbation assignment is also helpful in comparing the transportation network improvement alternatives which differ slightly (for example, an alternative involving small capacity expansions for a few links).

Implementation Recommendations

The improved planning framework with the post-processing technique developed in this study will provide a better solution with less noise and a higher level of convergence compared to the conventional four-step planning process. In addition, the solution obtained by adopting this methodology will have a more stable and consistent solution and thereby will increase the reliability of the assignment process.

To facilitate seamless implementation by planning agencies, an executable code was generated for the post-processing module after proper integration of all the three techniques, namely SMPA, perturbation assignment and O-D prioritization. It is a generalized code which can be used for any network and on any computer with sufficient memory. It does not require any other software to implement this module. The developed module can be used as a post-processor or an independent traffic assignment solver. Guidelines provided with this report will help in proper formatting of the required input data files for this module.



Recommended state-wide planning model.

References

Peeta, S., Kumar, A., & Sharma, S. *Post-processing Techniques to Enhance Reliability of Assignment Algorithm Based Performance Measures*. Publication FHWA/IN/JTRP-2011/19. Joint Transportation Research Program, Indiana Department of Transportation and Purdue University, West Lafayette, Indiana, 2011. DOI: 10.5703/1288284314643

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